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Bridge Construction Scheduling

KEYWORDS: Project Management, Bridge, Primavera

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ABSTRACT This paper emphasizes on the use of softwares for scheduling purposes in Project Management. In India,tedious and time consuming conventional methods are still used for project management instead of using modern software tools.

The Hadapsar-Saswad bridge in Pune is selected for construction scheduling as a case study.In this project the activities were first listed out,quantities were estimated,resources were allocated and hence a final schedule was created.Some suggestions were made on the site so as to overcome the obstacles on the site without affecting the project's duration and also not hampering too much with the cost.

Smoothing and Tracking were done using the softwares and the results were analysed to find the optimum time of construction.The variation of time and cost can hence be analysed along with the constraints to finalize a given project schedule.After scheduling on Microsoft Project and Oracle Primavera,the results are analysed to give suitability of the given softwares for specific circumstances.

I. INTRODUCTION

Scheduling basically means determining the inter-relationship of various activities of a project.The activities are first listed out and then their duration is estimated on the basis of past experiences.The activities in which the duration cannot be precisely estimated,such as for research work cannot be used in these softwares.The resources are first made and their cost per shift is specified,then these are allocated to the listed activities.The resources can be men,material or money.Whenever the project is updated by reviewing the work on the site,a baseline has to be created to as to update the progress of the work upto the given date.

II. UTILILTY OF THE SOFTWARE

The modern softwares based on Project Management help in scheduling the given project much faster than the conventional methods.By feeding the tasks,subtasks,durations and predecessors,the schedule is created automatically along with the Gant chart.The resources allocated for the given activity can be seen by inserting a column of resource names.Customised sheets can be created which show the actual cost and the planned cost which helps in calculating the

variances. Tracking of the project can be done so as to check whether the project is running on time or not.If the project is behind schedule,necessary actions need to be taken so as to pick up the construction speed without affecting the project cost to a great extent.A baseline is created on the day the tracking is done on the site and the percentage completion of work is found out.In the tracking sheet if there are any over-allocated resources,the software automatically changes their font to red.The project manager can then take necessary action for proper allocation of resources for the given over allocated activity.The resource usage of a given day can be seen.

Smoothening and Crashing

Smoothening is the process of increasing the duration of the activity without affecting the resources which are being used on the project.Onlynon critical activities are smoothened.

Crashing is the process of increasing the resources of a critical activity,which would reduce the time taken by the given activity.By crashing a given activity,the critical path of the given project may also change if a parallel activity has more duration than the activity which has been crashed.

Case study: Phase I,GaditalBridge,Hadapsar

Tender No: 44-2010
Advertise No:3-437-2010
Department name:JNNURM Cell
Estimated cost: 25 Crores
Earnest Money deposit(EMD):25 Lakh
Work period:24 months
The construction is done in the phases as shown below.
Phase 1-A:Pune to Saswad(P27-P14)
Phase 1-B:Saswad to Pune(P1-P10)
Phase 2 :Slip roads Saswad to Pune,285m approach
Phase 3-A:Pune to Saswad(P14-P10)
Phase 3-B:Pune to Saswad(P9-P1)
Out of all the contractors, J.KumarInfraprojects Ltd was selected for the construction of the bridge.

A. Details of the Gadital Bridge

The main purpose of constructing the bridge is to reduce the traffic on the existing highway.The overall cost of the bridge is 25 Crores.There are two flyovers,one is from Pune to Saswad and the other from Saswad to Pune.There are 27 piers for Pune to Saswad and 9 piers for Saswad to Pune.The approach length of Pune to Saswad flyover is 80m and it is 106m for Saswad to Pune.The spans vary from 25 to 30m.The total clearance of the Pune to Saswad flyover is 5m from the existing Pune-Solahpurhighway.Every pier foundation is having four piles of 1.2m in diameter and 7.5 m to 10 m deep to carry the superimposed loads.

First the traffic survey is done on the existing road so as to find the number of lanes that would be required. If the number of lanes required is less than that provided then the road is widened.The survey is done for 7 days so as to find out the number of vehicles passing the road.
All vehicles are counted as cars by taking the following equivalencies.

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1 Bus	3.5 cars
1 Tractor	2 cars
2 Bikes	1 car

For State Highways,
No of lanes required=total vehicles crossing/1200
For the GaditalBridge, road widening had to be done from 7.5m to 8.5m.

The various stakeholders were:
(I) Pune Municipal Corporation-Owner
(ii) S.N.Bhobe and Associates Private Limited-Consultant
(iii) J.KumarInfraproject Private Limited-Contractor

I. ACTIVITIES IN THE PROJECT
(I) Preliminary Activities
a) Setting up of site office
b) Site and Topographic Survey
c) Geotechnical Investigation
d) Setting of batching plant
e) Setting up of Fabrication yard
f) Setting of Labour camp

(ii) Foundation
a) Pile Boring
b) Pile Capping

(iii) Substructure
a) Pier
b) Pier caps
c) Bearing

(iv) Superstructure
a) Cast in situ PSC Box Girder
b) Construction of Deck Slab
c) Diaphragm

(v)Finishing Items
a) Anti crash barrier and railing
b) Drainage System
c) Wearing coat and expansion joints
d) Painting
e) Street lighting and electrical works
f) Traffic signs

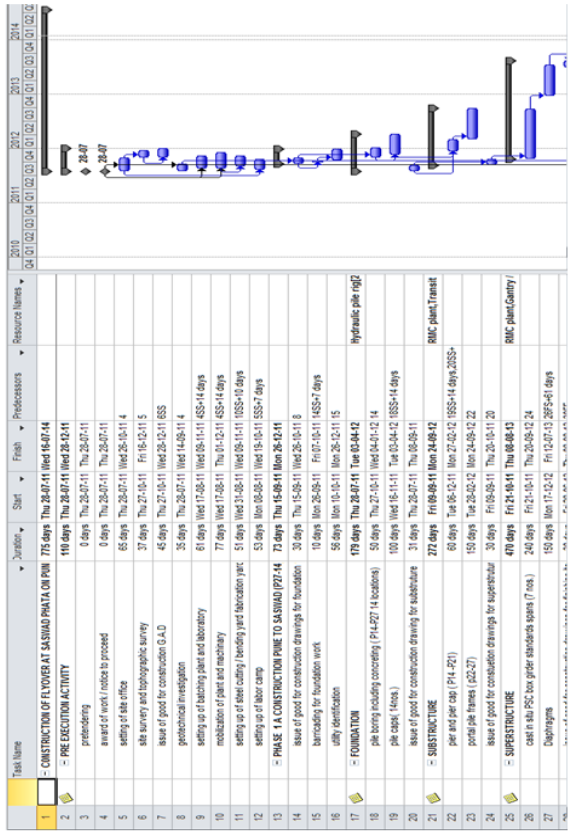
I. COST ANALYSIS OF THE GADITAL BRIDGE
TABLE I

Preliminary Activities	17.84 Lakh	0.71%
Foundation and Structure	5.57 Crores	22.28%
Superstructure	13.66 Crores	54.64%
Solid Approaches	87.33 Lakh	3.49%
Road Works	4.20 Crores	16.82%
Traffic signs	15.38 Lakh	0.61%
Landscaping and street furniture	2.45 Lakh	0.10%
Electrical Works	32.59 Lakh	1.30%

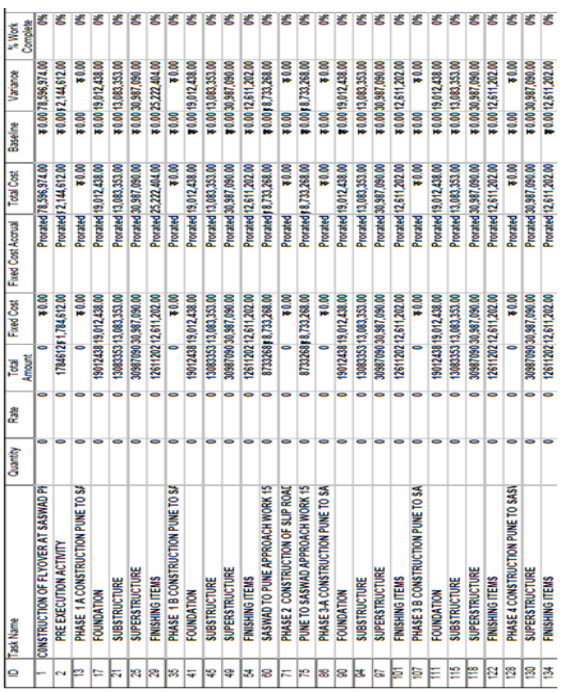
TABLE II
Machineries Used on the site:

Transit Mixer	4
R.M.C. Plant	1
Concrete Pump	2
Tyre mounted crane	1
Hydraulic Pile Rig	2
Equivalent excavator	1
Hydraulic tipper and dumper	6
J.C.B.	2
Prestressing jacks	2

I. SCHEDULING USING MICROSOFT PROJECT AND ORACLE PRIMAVERA
i)Activity Bar Chart:-After feeding of tasks, sub –tasks, durations and predecessors.schedule is generated automatically.
Bar chart shows the required units and quantities of resources assigned toto the activities.



ii) Customised Sheets:
It shows the actual cost and the planned cost which helps in calculating the variances.



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iii)Tracking:

It is the process by which the progress of the project is measured by monitoring.If the project is behind schedule then necessary actions need to be taken so as to pick up the construction speed.Tracking cannot be done without creating a baseline.

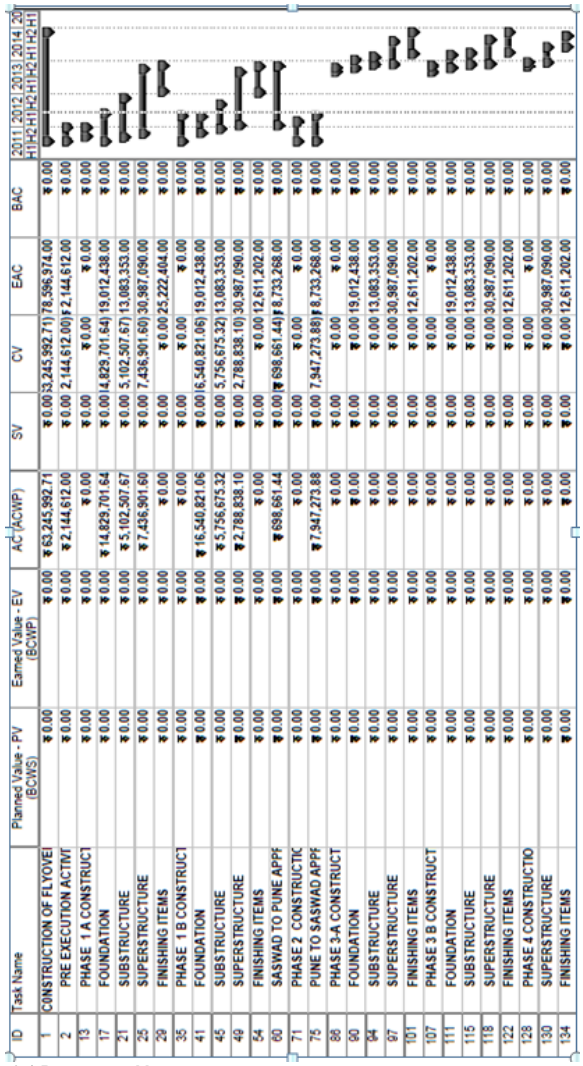
ID	Task Name	Quantity	Rate	Total Amount	Fixed Cost	Fixed Cost Accrual	Total Cost	Baseline	Variance	% Work Complete
1	CONSTRUCTION OF FLYOVER AT SASWAD PI	0	0	0	₹0.00	Prorated	₹8,596,974.00	₹0.00	₹8,596,974.00	0%
2	PRE EXECUTION ACTIVITY	0	0	1784612	₹1,784,612.00	Prorated	₹2,144,612.00	₹0.00	₹2,144,612.00	0%
13	PHASE 1 A CONSTRUCTION PUNE TO SA	0	0	0	₹0.00	Prorated	₹0.00	₹0.00	₹0.00	0%
17	FOUNDATION	0	0	19012438	₹19,012,438.00	Prorated	₹19,012,438.00	₹0.00	₹19,012,438.00	0%
21	SUBSTRUCTURE	0	0	13083353	₹13,083,353.00	Prorated	₹13,083,353.00	₹0.00	₹13,083,353.00	0%
25	SUPERSTRUCTURE	0	0	30987090	₹30,987,090.00	Prorated	₹30,987,090.00	₹0.00	₹30,987,090.00	0%
29	FINISHING ITEMS	0	0	12611202	₹12,611,202.00	Prorated	₹25,222,404.00	₹0.00	₹25,222,404.00	0%
35	PHASE 1 B CONSTRUCTION PUNE TO SA	0	0	0	₹0.00	Prorated	₹0.00	₹0.00	₹0.00	0%
41	FOUNDATION	0	0	19012438	₹19,012,438.00	Prorated	₹19,012,438.00	₹0.00	₹19,012,438.00	0%
45	SUBSTRUCTURE	0	0	13083353	₹13,083,353.00	Prorated	₹13,083,353.00	₹0.00	₹13,083,353.00	0%
49	SUPERSTRUCTURE	0	0	30987090	₹30,987,090.00	Prorated	₹30,987,090.00	₹0.00	₹30,987,090.00	0%
54	FINISHING ITEMS	0	0	12611202	₹12,611,202.00	Prorated	₹12,611,202.00	₹0.00	₹12,611,202.00	0%
60	SASWAD TO PUNE APPROACH WORK 15	0	0	8733268	₹8,733,268.00	Prorated	₹8,733,268.00	₹0.00	₹8,733,268.00	0%
71	PHASE 2 CONSTRUCTION OF SLIP ROAD	0	0	0	₹0.00	Prorated	₹0.00	₹0.00	₹0.00	0%
75	PUNE TO SASWAD APPROACH WORK 15	0	0	8733268	₹8,733,268.00	Prorated	₹8,733,268.00	₹0.00	₹8,733,268.00	0%
86	PHASE 3-A CONSTRUCTION PUNE TO SA	0	0	0	₹0.00	Prorated	₹0.00	₹0.00	₹0.00	0%
90	FOUNDATION	0	0	19012438	₹19,012,438.00	Prorated	₹19,012,438.00	₹0.00	₹19,012,438.00	0%
94	SUBSTRUCTURE	0	0	13083353	₹13,083,353.00	Prorated	₹13,083,353.00	₹0.00	₹13,083,353.00	0%
97	SUPERSTRUCTURE	0	0	30987090	₹30,987,090.00	Prorated	₹30,987,090.00	₹0.00	₹30,987,090.00	0%
101	FINISHING ITEMS	0	0	12611202	₹12,611,202.00	Prorated	₹12,611,202.00	₹0.00	₹12,611,202.00	0%
107	PHASE 3 B CONSTRUCTION PUNE TO SA	0	0	0	₹0.00	Prorated	₹0.00	₹0.00	₹0.00	0%
111	FOUNDATION	0	0	19012438	₹19,012,438.00	Prorated	₹19,012,438.00	₹0.00	₹19,012,438.00	0%
115	SUBSTRUCTURE	0	0	13083353	₹13,083,353.00	Prorated	₹13,083,353.00	₹0.00	₹13,083,353.00	0%
118	SUPERSTRUCTURE	0	0	30987090	₹30,987,090.00	Prorated	₹30,987,090.00	₹0.00	₹30,987,090.00	0%
122	FINISHING ITEMS	0	0	12611202	₹12,611,202.00	Prorated	₹12,611,202.00	₹0.00	₹12,611,202.00	0%
128	PHASE 4 CONSTRUCTION PUNE TO SASV	0	0	0	₹0.00	Prorated	₹0.00	₹0.00	₹0.00	0%
130	SUPERSTRUCTURE	0	0	30987090	₹30,987,090.00	Prorated	₹30,987,090.00	₹0.00	₹30,987,090.00	0%
134	FINISHING ITEMS	0	0	12611202	₹12,611,202.00	Prorated	₹12,611,202.00	₹0.00	₹12,611,202.00	0%

iii)Earned Value Table:

B.C.W.S.(Budgeted Cost Work Schedule)
B.C.W.P. (Budgeted cost work performance)
A.C.W.P. (Actual cost work performance)

C.V.(Cost variance) = B.C.W.P. – A.C.W.P.
If C.V. is negative then there is cost over budget
If C.V. is positive then there is cost under budget

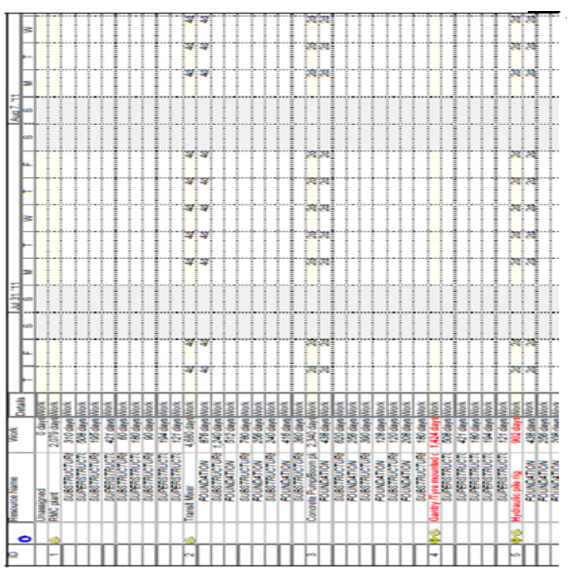
SV (Schedule Variance) = BCWP-BCWS
If +ve then ahead of schedule
If –ve then behind schedule
EAC-Estimate At Completion
BAC- Budget At Completion
VAC(Variance At Completion)=EAC-BAC



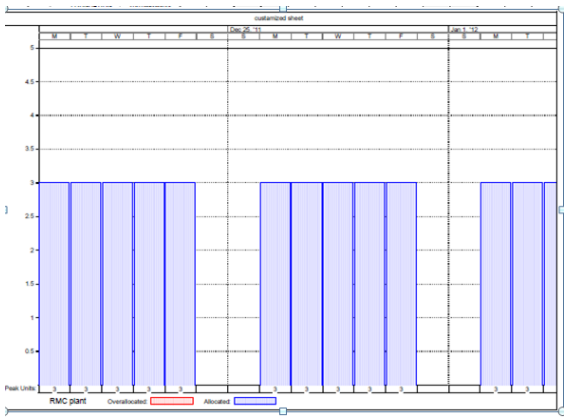
ID	Task Name	Planned Value - PV (BCWS)	Earned Value - EV (BCWP)	AC (ACWP)	SV	CV	EAC	BAC
1	CONSTRUCTION OF FLYOVEI	₹0.00	₹0.00	₹63,245,992.71	₹0.00	(53,245,992.71)	₹8,596,974.00	₹0.00
2	PRE EXECUTION ACTIVI	₹0.00	₹0.00	₹2,144,612.00	₹0.00	2,144,612.00)	₹2,144,612.00	₹0.00
13	PHASE 1 A CONSTRUCT	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00
17	FOUNDATION	₹0.00	₹0.00	₹14,829,701.64	₹0.00	(4,829,701.64)	₹19,012,438.00	₹0.00
21	SUBSTRUCTURE	₹0.00	₹0.00	₹5,102,507.67	₹0.00	5,102,507.67)	₹13,083,353.00	₹0.00
25	SUPERSTRUCTURE	₹0.00	₹0.00	₹7,436,901.60	₹0.00	7,436,901.60)	₹30,987,090.00	₹0.00
29	FINISHING ITEMS	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹25,222,404.00	₹0.00
35	PHASE 1 B CONSTRUCT	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00
41	FOUNDATION	₹0.00	₹0.00	₹16,540,821.06	₹0.00	(6,540,821.06)	₹19,012,438.00	₹0.00
45	SUBSTRUCTURE	₹0.00	₹0.00	₹5,756,675.32	₹0.00	5,756,675.32)	₹13,083,353.00	₹0.00
49	SUPERSTRUCTURE	₹0.00	₹0.00	₹2,788,838.10	₹0.00	2,788,838.10)	₹30,987,090.00	₹0.00
54	FINISHING ITEMS	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹12,611,202.00	₹0.00
60	SASWAD TO PUNE APPI	₹0.00	₹0.00	₹698,661.44	₹0.00	(₹698,661.44)	₹8,733,268.00	₹0.00
71	PHASE 2 CONSTRUCTIC	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00
75	PUNE TO SASWAD APPI	₹0.00	₹0.00	₹7,947,273.88	₹0.00	7,947,273.88)	₹8,733,268.00	₹0.00
86	PHASE 3-A CONSTRUCT	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00
90	FOUNDATION	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹19,012,438.00	₹0.00
94	SUBSTRUCTURE	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹13,083,353.00	₹0.00
97	SUPERSTRUCTURE	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹30,987,090.00	₹0.00
101	FINISHING ITEMS	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹12,611,202.00	₹0.00
107	PHASE 3 B CONSTRUCT	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00
111	FOUNDATION	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹19,012,438.00	₹0.00
115	SUBSTRUCTURE	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹13,083,353.00	₹0.00
118	SUPERSTRUCTURE	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹30,987,090.00	₹0.00
122	FINISHING ITEMS	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹12,611,202.00	₹0.00
128	PHASE 4 CONSTRUCTIO	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00
130	SUPERSTRUCTURE	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹30,987,090.00	₹0.00
134	FINISHING ITEMS	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹12,611,202.00	₹0.00

iv) Resource Usage:

It shows the allocated and over all ocated resources.Necessary action can be taken for the overallocatedresources.Thessoftware automatically changes the font of the resource to red so as to show over allocation.



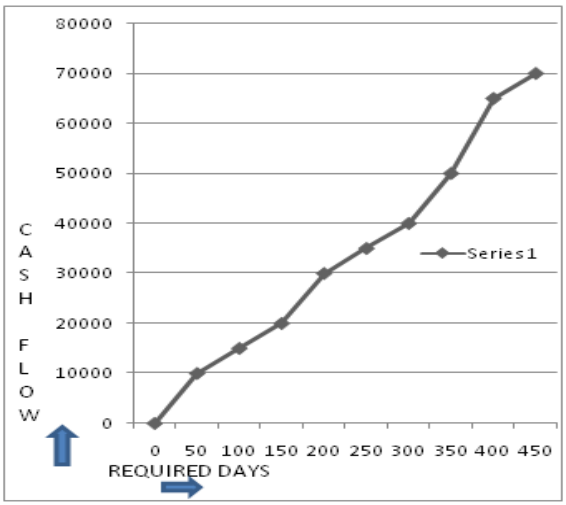
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v) Comparison Between Crashing and Smoothing

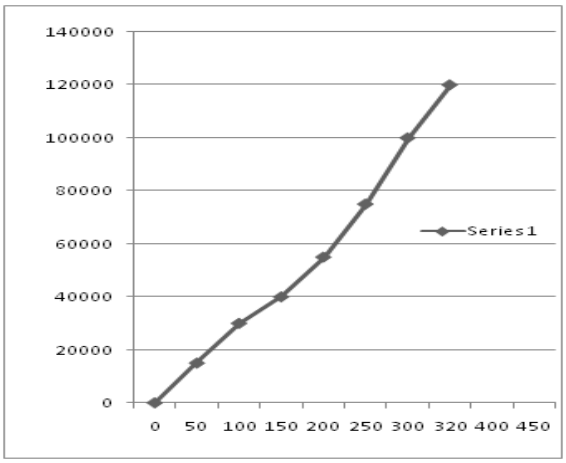
A.Smoothing

Smoothing is the process of increasing the duration of the activity without changing the amount of resources that have been used.Smoothing is done for non critical activities.



B.Crashing

Crashing is the process of increasing the amount of resources used for critical activities and hence reducing the duration of the activity.By crashing a few activities,they may not remain in the critical path as their duration might be lesser than a parallel activity.



I. ADVANTAGES OF PRIMAVERA OVER MICROSOFT PROJECT

If the company has more than one project to handle,the CEO can get access to all the projects under him on the same interface,which is not possible in Microsoft Project.The manger assigns the CEO of the company as the project superuser which gives him unmilimitedaccess.The other subordinates of the company are given limited access by the software.Every user is assigned a unique login Id and password.

Resources and calendars once made in PRIMAVERA can directly be made global and can be used in multiple projects without creating new ones again and again.

It can now be used directly on the internet,the version is Primavera P6 Release 6.2 Web.

II. CONCLUSION

After completion of the project,we are able to schedule a civil engineering project on Microft Project and Oracle Primavera.The obstructions on the site can be overcomed by past experiences and by taking maximum advantage from the software's analysis.

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